THE WASTAGE OF OUR COAL FIELDS.

BY DR. EDWARD ORTON.

Mr. President and Gentlemen of the Institute:

I have been able to prepare but a brief discussion of this subject and except in a very general way I have not grappled with the practical problems. I was disappointed a little in the time I had at my disposal for that purpose. May I introduce what I have to say by a little parable?

A staunch ship is sailing the high seas. A storm comes up that wraps the heavens in gloom and drives the ship far out of her course. For days the tempest is upon her. By the fury of the gale her sails are torn into ribbons. By the force of the waves, masts, spars, rudder, are all swept away and she now rolls heavily in the trough of the sea, a helpless wreck, waiting the kind approach of some monster billow that shall complete the work of destruction. Passengers and crew have long since abandoned all hope of a safe outcome, but at last a change comes in the situation. It becomes evident that the storm-beaten hulk is drifting on to an unknown shore. The terrible roar of the breakers rises above the roar of the storm. At last she strikes the cruel rocks and quickly goes to pieces. But, as by a miracle, a few of the crew reach the shore alive. Morning comes and the survivors find themselves on a desert island, bare, bleak and inhospitable. They wander over its surface in the vain search for food, for anything to sustain their starving frames, but at last, in a protected bay, they come upon some traces of recent human occupation and under a sheltering cliff, they discover a small supply of food, evidently left by shipwrecked predecessors that had at last been rescued.

The sailors are transformed by this discovery. They forget the dangers of their situation and set about the immediate utilization of the new found stores. They struggle with each other for the first chance at the supplies and, in their greed, a third to a half of the precious stock is hopelessly lost. One of their number raises a mild remonstrance against this reckless and needless waste on the ground that they may need every grain of the food themselves, but he is speedily whistled down the wind as a pessi-

mist of the darkest dye. Other stores, larger and richer than the first may be awaiting their discovery, or a passing ship may sight them to-morrow to carry all back to plenty again.

These shipwrecked sailors, quarrelling over and wasting the little store of food that stands between them and possible starvation are splendid examples of provident foresight and practical wisdom, compared with the most advanced communities of the nineteenth century in their treatment of coal.

The difference is that the sailors will suffer the penalty of their shortsighted greed in their own persons, but we, spending our own lives in barbaric profusion, leave all the loss and burden of our reckless waste to fall upon the innocent generations that will succeed us.

There is one mineral that man has discovered that stands by itself in the wealth of the world. That mineral is coal. Coal is the mainspring of our modern civilization. It is what distinguishes the modern world from the old world, the nineteenth century from all the centuries that have preceded it. To it we owe all the miracles of locomotion, transportation and manufacture by which our time is characterized. Upon it all the more progressive and civilized portions of the world are coming to depend more and more absolutely. As yet, we see no way by which the characteristics of our day can be maintained without coal. If coal were cut off to-morrow every railway locomotive in the country would "die" on the track, the paddles and screws of every steamboat on river, lake or sea would cease to turn, all electric cars would find themselves "off their trolleys," every machine in every factory would slow down to a final rest. The heat, the light, the water supply of every town would be at once withdrawn. In fact, every great city north of the fortieth parallel in our hemisphere would of necessity be at once abandoned.

Of course there are a few exceptions to these statements. Wood is burned under the boilers of a few locomotives and steamboats and here and there an electric current is generated by water power, but these exceptions make no figure in the grand total.

Such is coal in relation to the modern world. How long have we had the advantages of it? I will confine myself to the facts in regard to our own country. Coal in the United States began to be used about the beginning of the present century. In Great Britain, another century could be counted in.

In 1803 the first shipment of anthracite to Philadelphia was made. Sixty tons were sent from the Lehigh valley by barge or raft down the river. Most of it was lost in transit, but the

balance was rejected in the city markets as unfit for fuel. But by 1820, by dint of certificates and sworn statements from judges of courts, college professors and the like, it was made probable to intelligent people that after all, anthracite could be made to burn. In that year, 1820, regular shipments began from the Lehigh valley to Philadelphia. The total amout shipped in that year was 365 tons, one ton for every day in the year; but this amount was somewhat in excess of the demand and the market was for a time overstocked and dull. But year by year the demand increased until in 1840, the total production of Pennsylvania had grown to 800,000 tons, the most of it anthracite.

A new impulse to the trade was given in 1836. Nicholas Biddle, the distinguished financier, offered in that year a prize of $5,000 to any iron furnace of the State that would run on anthracite alone for 100 consecutive days. The prize was not won, however, until 1839.

Thus you see it is the last half of the century only that has had the service and advantage of coal so far as this country is concerned.

The rate of increase in its use has been extraordinarily rapid since the dates I have named. One million tons in 1840 has grown nearly two hundred fold in 1896.

Is coal in process of growth or increase within the earth? No one, so far as I know, claims this. Even the learned Thebans that were accustomed to demonstrate, a dozen years ago, in the columns of the newspapers that natural gas was being manufactured underground as fast as it was being withdrawn and would continue so to be produced as long as the internal heat of the earth was maintained, never ventured to extend their claim to coal, and even the theory of continuous gas production seems of late to have fallen into "innocuous desuetude."

All the coal that is available to the human race is already stored within the crust of the earth. This is the same as saying that like the hairs of our heads, the tons of coal within the crust are numbered and that every ton taken away from the store leaves the number less.

Is the amount so vast that it is practically infinite, that it is not necessary to regard it? On the contrary, the areas are so limited that the presence of coal is the rare exception rather than the rule. Not a pound is found in New England, New York, New Jersey, Delaware, Virginia, the Carolinas, Georgia, Florida, or the seaboard states. Pennsylvania supplies them all, and the noble fields of this great State are beginning to show the strain, even after only fifty years of service.

Measurements based on the present rate of consumption have been made in several of our fields. The figures presented as the result of these calculations are not encouraging. A few hundred years, a thousand, at the longest, are given as the limit of life of these measured fields, and they are the best we have.

But perhaps these few hundred years are enough. Perhaps, as our millenarian friends teach, the end of all things is at hand, the Judge is at the door. For my own part, I cannot bring myself to accept this view. It is only the morning of the world in which we are living. It is only March in the circle of man's year. His golden summer lies before him. Man cannot fulfill his destiny without many millenniums of discipline and growth at his service. He is just now attaining a comprehension and mastery of nature that hold the promise of the future. He is just learning how to live. To cut short the development at this point would make his whole history abortive and meaningless.

No; we are not doomed to so lame and impotent a conclusion. We have yet many thousands of years before us. The kingdom has not come, but it is coming. God's will is not done on earth as it is in heaven, but it is to be, and man will live to do it.

Astronomers tell us that the sun has a stock of light and heat that will last six million years beyond the present. Surely of this vast period a few thousand years at least will be assigned to man for his development and perfection. The earth gives no sign of waxing old and being ready to perish.

> "The years no charm from Nature take,
> As sweet her voices call,
> As beautiful her mornings break,
> As fair her evenings fall."

But perhaps some new source of heat and power will be discovered. In my opening parable, the sailors held a like view. Far be it from me to belittle or underrate the triumphs of modern science. I have in mind an illustration of how blind the best of us may be to what is very near at hand. Fifty years ago I saw a little wheel, two inches in diameter, made to revolve rapidly by a current of electricity. The professor exhibiting it to us made haste to assure us that the electric current was a plaything only and that there was no probability that it could ever be turned to practical account. When we think what electricity is doing now underground as well as above ground, it makes us modest in predicting the possibilities, or denying the possibilities of astounding advances in that line.

I know what is being done by Niagara and other natural powers of the world. I know what a marvelous economy of

power is secured by the production of electrical energy. I am prepared for many and great advances.

But, gentlemen, I do not see any reason to believe that a pound of coal will ever become an object of small account to the inhabitants of the world. I think to the end of time we shall value these resources. I know it will be made to go farther. Economy will be practiced in that way; it will be burned to better advantage. All our methods are barbaric in their wastefulness now.

Now, I come to the subject of wastage of coal in our fields. I am not going over the ground again: you all know it better than I, you can analyze the sources of waste, you see the different elements which enter in and know how it comes about. I know that the conditions of trade seem to make it necessary to mine somewhat as we are doing now. These difficulties are obvious to us all. But the point I want to impress upon you is the importance of the economy in the use of coal and the preservation of it for years to come. It is not a very powerful motive to advance to a human being that he shall save, shall restrict himself and suffer some disadvantage or discomfort for the purpose of taking care of generations to live a hundred years from now. But it seems as if one power which expresses our united life, the power of the State, ought to be added to that demand. Here in Ohio, planted on its forty thousand square miles, and as far as we know the century which has passed into history will be repeated many times; many hundred years will pass over this area we call Ohio. And how will life go when these resources, which we are using so lavishly and wasting so recklessly—when these supplies are cut off, and cut off they must be, as far as we are concerned, within a few hundred years. Let all the economy come in that will; let all the improvements be originated that are in the future for us; still there will always be this value attaching to this precious form of power. I do not see the difficulties of the question as you do, and I do not know that you will occupy time with discussing these points. I had meant to cover a little more ground, but will relieve your attention. [Hearty applause.]

PRESIDENT RAY: Discussion of all these papers is now in order.

MR. LEWIS: With your permission I would like to make a little picture and tell a story to show that the miner is not the only factor in the wastage of coal.

A motion was made by Mr. Jennings, seconded by Secretary Haseltine, extending hearty thanks to Dr. Orton for his valuable and interesting paper. The call for a vote was responded to by a hearty and vigorous "aye."

MR. LEWIS: You know that picture writing was one of the earliest forms of conveying ideas, and I do not know that we have ever got far beyond it in the demonstration of proportions in scientific statements. Therefore, I make here a block (demonstrating on blackboard), which is supposed to represent a certain amount of coal in place. Now, it is hard to make an average which shall be anyway accurate, but in following up the subject, I suppose that 60 per cent. of that coal is delivered at the pit mouth—it is as good a figure as any—and therefore I will mark off 40 per cent. and this loss we will charge to the miner (illustrating). Then, if we follow that coal through the development of power we will find that with the best engineering practice it loses, between the coal delivered at the furnace door and the work units indicated in the cylinder, about 85 per cent., which brings us back somewhere near there (indicating on diagram), which represents our present practice in the development of power from coal. Now, then, our friends, the electricians, take another whack at it. In generating power, transmitting it and grinding it out in the motor, we lose about another 25 per cent. So that this loss we charge to the miner (indicating diagram), this here to the mechanical engineer (indicating), and this to electricity (indicating)—and I do not believe that the picture needs any further explanation or comment from me.

A MEMBER: Mr. Lewis, what becomes of the coal which is stolen off the cars in transit?

MR. LEWIS: Well, I think that is a very small percentage in comparison with what is stolen in other ways.

MR. WILLISTON: If you want to carry your point further, you can divide the last quantity left there by two, at least, in case the electric motor is used in driving some machine; because, as a rule, the efficiency of that machine is far from a hundred per

cent. But this demonstration is not, in one or two respects, hardly fair. Not all our coal is used in developing power, and in some other ways coal can be used with greater efficiency than in this. For instance, a very large quantity is used for metallurgical purposes, for reducing iron ore in blast furnaces, and so on. The loss of efficiency in these cases is nowhere near so great as demonstrated in this other direction. Again, a large proportion is used for heating dwellings and buildings during the colder months of the year, and in this case the efficiency is fairly good.

In regard to the waste in transforming coal into mechanical power, there is reason for that waste and it is not fair to call it waste. The heat utilized can only be utilized between certain temperatures. We can generate heat by the combustion of coal, but we can only utilize that portion of the heat which can be allowed to flow from one level to another level. If it is to be used under a steam boiler, the only heat which can be used in the steam engine is the difference of temperature between the steam when it enters and leaves the steam engine. And as long as our engines are made of iron and as long as we have to lubricate these engines, it is impossible to exceed certain fixed limits of upper temperature and we cannot get below certain fixed limits of lower temperature. So we can only utilize that proportion of the heat, and that is a small proportion as a rule of the whole, generally not over a quarter; certainly not over a third, in any case.

PRESIDENT RAY: I think Mr. Lewis' object in giving this demonstration was only to show approximate results, and it is certainly a forcible argument showing that such loss does exist. I would like to see a discussion along lines of preventing the waste of coal. We will be glad to hear from anybody who has any ideas as to the course to pursue to better the conditions of mining and save this wastefulness, which all these papers have shown us clearly does exist. As Dr. Orton has so ably stated, it is only a question of a few years comparatively, when our coal supply will be exhausted, and it appears to me to be our duty to do what we can to prevent this waste. I would like to hear a full and complete discussion along these lines.

MR. ED. HASELTINE: Mr. President, it seems to me, that the kernel in the nut was expressed by our President last night when he made the statement that those who are mining now ought to leave the coal, which for various reasons is not mined now, in such condition that it will be possible to reclaim it at a future time. I do not see how it is possible for us in any way to compel people to mine coal which is not profitable; but I believe by education the mine bosses and subordinates can be brought to the point of reclaiming what seems impossible now. I do not think the mine owners have any desire to leave coal in the mine; I think it is largely a matter of deception on the part of employes. I know I have frequently met bosses who undertook to cover up errors and omissions of their own by saying that the coal was all out when it was not. So I think it is only necessary to show to the owners what the bosses are doing, by showing complete maps of what is lost. If we show them the percentage which has been and is being lost, they will take means to put men in to reclaim it. But we cannot make them take out what is unprofitable. Therefore they should be compelled to leave it so that it will be available to future generations. I think that is the best thing we can hope to do.

MR. J. B. STRAWN: While I am not an active mining engineer at the present time, yet for many years I did considerable amount of work in the mines of eastern Ohio and the western edge of Pennsylvania. The thought has occurred to me in regard to the matter which has come up here for discussion, that there would be extreme difficulty if we should attempt to tell the man who owns a forest that he must not cut down his trees because it would tend to cause drought, because it would tend to put future generations in want of timber. It is also very questionable whether we can tell a man how he m st till his ground so as not to impoverish the soil; and I know it would be a difficult thing to tell a man who owns coal that he must leave it in such shape that it may be mined hereafter. These are things which come in and antagonize in one sense what are supposed to be inalienable rights of property. It is right along the line of profit to the engineer, more than anybody else, to show to his employer

that the course he is advising is for his best interest; to bring together all knowledge and ingenuity to show that certain methods are best for mining certain kinds of coal in certain localities and so advise the owner of the property. The mining engineers of this State have much greater influence than they had fifteen years ago when the Institute was first organized. Systematic work is being done, methods of mining are being discussed, and haphazard mining is certainly not being practiced now as it was fifteen years ago.

MR. ED. HASELTINE: I neglected to make one other point, as to the frequency with which mines are surveyed and maps extended. I have mines under my charge to which I go once in a year or year and a half and so on. At that time it is impossible to do anything but take the word of the mine boss for the work done. In England they require surveys made every three months; but I think a survey ought to be required for every thousand tons mined. If it did not exhaust much territory, then there would be nothing to do: but if it did, it would be impossible for any one to cover up any bad work, and the engineer would get there to make the survey before the pillars were down. It is the limit of territory worked that we want, and that ought to be accurate; if we must ake the mine boss's word for it it does not give much confidence if it is desired to approach from another direction.

MR. BALLARD: I am not a member of this Institute and come here from another State and district; but the matter which Dr. Orton brought out struck me quite forcibly. I come from Scranton, Pa., and I was interested in the mention made by Dr. Orton of the development of our anthracite industry, which has been accomplished most wholly in a generation. From present surveys of the anthracite district made with remarkable fullness, it is learned that there are some districts, some portion of the anthracite basins that will be exhausted in sixty years, and perhaps all of it, at the present rate of consumption, in a hundred years. I think from this statement, you can form some idea of the importance of preserving your coal fields. In regard to

knowing what you are getting and what you are not getting, perhaps our mine maps are made with greater accuracy than in other districts, but I think it highly important for you to have accurate mine maps. It seems to me that the mine operator has no one to thank but himself when he finds he is not winning the coal that he should from his property, when he only has surveys made once in three, six months or a year. This thing of taking some one else's word for what has been done to a certain extent is wholly guess work and very dangerous. There is no way to get out all the coal equal to having a map right up to date, so when the operator comes to his office, he can see whether the mine boss is working the coal as it should be, for six months or a year after it cannot be gotten. Some of the worst accidents have come in several instances from old workings made forty years ago, where the surveys were inadequate, and you seem likely to have the same trouble here.

A MEMBER: How often are your mines surveyed?

MR. BALLARD: Every mine keeps a corps of engineers practically busy all the time.

A MEMBER: Well, how often are the maps brought up to date?

MR. BALLARD: I could not say. I can simply reiterate what I did say, that a corps of engineers are constantly in the mine, and that a corps of engineers will have not to exceed two or three mines to look after. Of course the mines are large. An ordinary anthracite colliery will ship five hundred to a thousand tons per day, and this makes considerable ground to cover.

PRESIDENT RAY: It is the custom of several large companies of the Hocking Valley to require a survey of their mines once a month, and I suppose the anthracite companies have them as often, if not oftener. Mr. Doe, have you any ideas to give us on this important subject?

MR. DOE: Mr. President, I do not know that I have anything to add to what has been said. I may simply say that it seems evident that the fact that there is need of saving our coals

has been substantiated and that question does not need discussing. The question is, how to do it. Now, there has been a great deal said here about the wasteful methods of our miners and mining engineers. My observation has been, as a coal operator, owner and manager of mines, that we want to go a little higher than the coal miner and mining engineer: we want to get at the head of the concern. The laws of trade, the demands of competition have regulated this wasteful manner of mining to a great extent.

When a mining engineer or mine boss is called upon to open up a mine, the first question asked is, "How much is it going to cost?" The next question, "How soon can you give us some coal?" The next question which comes is, "How much is the coal going to cost?" And he is most generally met with the statement, before they have been shipping a great while, that the coal is costing too much, they can't afford it. Consequenly, he is forced by the owner of the mines, and the owner of the mines is forced by the laws of trade and competition, to put that coal in the market at the cheapest possible price. So that a great deal of wasteful mining is brought about in that manner. The man in charge of the mines is forced to get out the coal as cheap as possible and will gouge around for it, cutting here and there where he can cut the easiest and cheapest. If he comes across a portion that is hard cutting, the miners will say, "We cannot make any money cutting that coal," and leave it. I have had evidences of that in the last few years myself. I have had to pick up places so left and try to work them out to save them. I think we should commence our work with the owner as well as the subordinate. The mining engineer must show by his maps to the owner of the mine what he is losing every day by the present methods. He must also show him in such a way as to convince him that it is for his interest to spend a dollar to-day and get back fifty cents for it now, and get the other fifty cents in the future.

My observation is that in a mine where the work is progressing steadily, the mining engineer should go through at least once a month. He cannot have an intelligent idea of the mine without going through it at least that often. A man who is put in as

manager cannot get into the mine often enough to keep track of it unless he has a map correctly brought up. Consequently a map should be worked up and filled up accurately at least once a month. The engineer must not take the mine boss's statement of the situation, but he must go to the face of every working and get it accurately. If he does not do that, he is not doing his duty. This subject is a very serious matter and requires careful consideration.

MR. WILLIAMS: This matter, it seems to me, is not for this generation to accomplish. I do not think the competition which we have in this country and all over the world in the coal business will ever be stopped. I think the only thing which can be done is for the government to take hold of the coal mines in the country. I think that is the only thing which can be done to save the coal.

MR. BARNES: Mr. President, I have often thought of this subject, but I found on looking about that the same wastefulness exists in other branches. The same wastefulness exists in agriculture, in the use of our timber,—I might say in every branch I am acquainted with. How will it be remedied? I cannot see that it can be remedied unless the laws of trade are changed. A mine owner commences to mine his coal, and if that coal is not up to a certain standard of quality, he cannot put it into the market and sell it. The buyer is going to buy the best coal he can buy, price being equal. You can go into some of our large coal fields where a portion of the coal is unsalable, may be nearly a half of it did not come up to the requirements of trade and, of course, is left. A few years ago there was scarcely any demand for fine coal; now it is in demand because it is much cheaper. All these things depend upon the cost of getting it to market, and I cannot see how it is going to be remedied. Surely we cannot compel a mine owner to leave the unmined coal in such shape that it can be afterwards taken out, for that would be impossible in nearly all mines. We cannot reimburse him for stopping his mine. Some mines have great dips or inequalities, requiring vast expense for drainage, and others may have faults very difficult to

go through. All these things come into the question; and while I believe every person should be impressed with the importance of saving our coal, just as they should be with the importance of saving our timber and properly tilling the land, I cannot see how, under the existing state of things, matters can be remedied except by enlightening every one and letting them see for themselves the necessity for these things.

DR. ORTON: Only a word. An exhausted soil can be brought to life again; timber can be swept away and grown again; coal, a mineral form, once gone is gone forever. I believe in the proposition of Mr. Williams. Nothing but an heroic remedy will reach the case. I do not know how it is going to be brought about, but the common sense of the State will have to grapple with the problem at last and see to it that this wastefulness is stopped.

MR. BROPHY: Garfield once said that a man was too small for a position unless he was too large for it. I think this finds application to the mining foreman. I have met men who had charge of gaseous mines, with a large investment in machinery, etc., who had to keep time with dashes and dots and use hieroglyphics for other things, who could not write a report. It seems to be the prevailing opinion that if a company tries to save all the available coal, that company will surely fail. I believe that such efforts will be rewarded by the increased production of their territory. They pay so much for their coal and coal veins come high. If they can save a higher percentage of that coal I do not see why it will not be a better result in the end. The same objections were raised to proper ventilation, to proper drainage as are now raised to proper saving of the coal. Another point is the very limited knowledge of timber. I do not think myself that the wasteful methods can be checked altogether, but they can be eliminated to a degree. I claim that life is too short for a man to learn all he should know about the working of a mine from his own experience. He should use the experience of others to help him to solve his own problems.

MR. RUTLEDGE: It seems to me, Mr. President, that the question has resolved itself into a commercial one. The more I travel, the more I have looked over the country during the last four months, the more I have seen of this waste. Think of the room and pillar, double entry mines in Illinois getting 50 or 60 per cent. of the coal and leaving 40 per cent. in pillars, and throwing 15 per cent. of that mined back in the gob. The mine owner pays for the mining and shoveling and then 15 per cent. is thrown back in the gob. If we can bring home to the operator the fact that that coal can be profitably marketed it would settle the whole case, and I think that can be demonstrated.

The whole question of coal waste to my mind resolves itself into two heads. First, your choice between one of two systems, long wall advancing and retreating and room and pillar. Under the best systems of long wall we get 90 per cent. of the coal. Where it is impracticable to use long wall, we must use room and pillar as ordinarily used, double entry; and working, as I have seen them work in the Congo and in the mines of West Virginia, get 80 to 90 per cent. of the coal in the bed out. Aside from the washing of the coal, is the briquette industry, which is commending itself to the people of this country. There is a plant at Springfield, Illinois, in which they are preparing to make briquettes, using some adhesive substance, I think pitch. They are making briquettes there more as an experiment than anything else. We do not see so much waste in this State as in other states probably West Virginia has the least waste of all.

SECRETARY HASELTINE: I move you, Mr. President, that the committee of ten which were selected last year to investigate this subject, be continued for another year, with instructions to continue their investigations and report at the next annual meeting as to some means of preventing this unnecessary waste of our coal.

I do not think anybody has overestimated the percentage of waste in this State. I think fully 40 per cent., if not more, of the veins already opened is lost.

Motion seconded, and after some discussion same laid on the table until evening session.

On motion meeting adjourned until 7:30 p. m.

EVENING SESSION — JANUARY 21, 7:30.

PRESIDENT RAY: We will begin at the end of the program and work backward. Mr. Keighley, who is named last on the program, is not present and our old friend, Mr. Lewellen, who has acted for him in this way before, will read the paper for Mr. Keighley.